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DETERMINATION

OF THE

MOTION

OF THE

SOLAR SYSTEM

IN

FIXED UNALTERABLE SPACE.

BY MARTIN GARDINER, C.E.,
(OF THE QUEEN'S UNIVERSITY.)

Brisbane
WOODCOCK & CO., PRINTERS, 101 ALBERT STREET.
1883.

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THE author claims the honour of being the first mathematician who has solved this problem of the determination of the motion of the Solar System in fixed unalterable space.

Laplace, in his "*Mécanique Céleste,*" endeavours merely to determine what he designates the invariable equator of the Solar System. He carelessly assumed that the Sun has no orbit, and that the locus of the centre of gravity of the system is necessarily a straight line fixed in space. He did not perceive that the principal axis of moments is the only invariable line pertaining to the system, and that his plane (if properly indicated?), may be any plane whatever to which such axis is normal.

Poinsot attempted to perfect Laplace's method of finding the plane sought for; but he based his reasoning on erroneous ideas consisting of imputed attributes of centres of gravity and influencing power in the rotatory motions of the planets and other entities round their respective polar axes.

See his memoir entitled "*Théorie et détermination de l'équateur du Système Solaire,*" presented to the Institute of France, 24th March, 1828.

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the various entities of the Solar System at any instant; to find the respondent principal axis of rotation of the system (should such exist)—the rotatory velocity of the system round the axis,—and the translation velocity of the system in the direction indicated by the axis, &c.

2°.—The method of solving the problem is obviously as follows:—

We proceed with our computations as if no other force than those of attractions influenced the translation velocity of the Sun's centre; and we work out the results of numerous special examples or *cases*, for instants of chosen epochs when the entities of the Solar System are in differently-arranged relative positions.

If we find that the resultant forces obtained are identically the same in all the worked-out cases; we know that the Sun cannot be influenced by any force which could cause motion of translation to its centre, other than those of the attraction forces.

But if we find that the resultant forces obtained are not identical; we then know that such incompatibility must be entirely owing to the omission of some simple force, other than one of attraction, whose line of action passes through the Sun's centre; for it is evident that the reciprocal forces of attraction are always a set in equilibrium, and can never have any effect in altering the resultant of the other forces under consideration, —their office consisting of binding the entities together according to some law which it is obviously unnecessary to consider in the solution of the present question. We must then find that omitted force *for each example* or case of compution, both in direction and magnitude, which, introduced into the data, would cause the various worked-out resultant forces to be identical.

We can then easily find the magnitude and line of action of the resultant of the forces of attraction and the supplementary introduced force pertaining to each case (all of whose lines of action pass through the Sun's centre), and thus arrive at the magnitudes and lines of action of the respective simple forces which give to the Sun's centre the apparent motions it must have at the respective instants of the epochs for which the computations (of the cases) were made.

We at once perceive the correctness of the following statements (see the author's solution to the celebrated fundamental question of Dynamics):—

3°.—If all the forces (having their lines of action through the centres of gravity of the various entities of the system, and causing the respective apparent motions of such centres of gravity) have as resultant a couple force; then there can be no motion of the system, as a whole, in space. And we perceive that the representative axis of the couple is constant in magnitude, and constant *in direction in space*; and will remain so to all ages.

4°.—If all the forces reduce to a simple resultant force; the line of action of such force is the central axis of moments; and the motion of the system must be one of determinable translation only, in the direction indicated by this central axis of moments. And we perceive that this central axis of moments is fixed or unalterable in space, and can be re-determined or found at all epochs in future ages——no matter what may be the changes in the mutual attractions of the entities of the Solar System, or in the planes of their orbits, &c.

5°.—If all the forces reduce to a simple resultant force, and an associate resultant couple force having its representative axis coincident with the line of action of the simple force; then the line of action of the simple resultant force is the central axis of moments; and the motion of the system is composed of a determinable motion of translation in the direction indicated by the central axis of moments, and a determinable motion of rotation round such central axis, as principal axis of rotation. And we perceive that the central axis of moments is fixed or unalterable in space, and can be re-determined or found at all epochs in future ages——no matter what may be the changes in the mutual attractions of the entities of Solar System, or in the planes of their orbits, &c.

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6°.—The method of determining what may be properly called the Sun's apparent orbit, and his periodic time, are evident from what has been exposed. To determine *the periodic time* requires that we should continue to find the resultant forces until we find cases in which the lines of action of the computed forces causing the apparent motion of the Sun's centre are identical. For all those lines of action are tangents to the apparent orbit of the Sun's centre.

7°.—Should any one think (with Poinsot) that the rotations of the entities of the Solar System, round their respective polar axes, influence the general movement, he can supply easily determinable couple forces, representative of their respective powers or effects, in the data of the different example or cases, and find the resultant forces, &c. But, to the author of the present memoir, the idea is obviously absurd.

8°.—There are other questions concerning the Solar System well worthy of investigation, one of which is the determination of the cause of the rotative motions of the Sun, Planets, and Satelites round their respective polar axes,—whether all are owing to one great couple force emanating from the Sun, and having its axis coincident with the Sun's polar axis? The author has written concerning this interesting question to his kind and valued friend Professor Townsend, of the University of Dublin, who is the most distinguished British Geometer of the day,

WOODCOCK AND CO., PRINTERS, ALBERT STREET. BRISBANE.

DETERMINATION OF THE MOTION OF THE SOLAR SYSTEM.

ADDITIONAL,—ON ITS CENTRE OF GRAVITY.

9°.—Theorems relating to the centre of gravity of the Solar System can be easily arrived at by means of the following well-known theorem:—The momentum of a system of bodies is the same as if all their masses were concentrated at the centre of gravity of the System. (See Macquorn Rankine's "Applied Mechanics.")

10°.—Should all the forces (having their lines of action through the centres of gravity of the various entities of the System, and causing the respective apparent motions of such centres of gravity) reduce to a simple resultant force; then will the centre of gravity of the System be an apparently fixed point, situated either in the central axis of moments or at a constant determinable distance therefrom (as may be); and the real or *true locus* of such centre of gravity will be, accordingly, either the central axis of moments, or a determinable fixed straight line parallel to the central axis of moments.

11°.—Should all the forces reduce to a simple resultant force, and an associate resultant couple force having its representative axis coincident with the line of action of the simple force; then will the centre of gravity of the System have as *apparent locus* a determinable circle whose centre is the point in which its plane is pierced normally by the central axis of moments; and the *true locus* of such centre of gravity will be a determinable regular circular spiral or hélice, whose axis is the central axis of moments.

12°.—The forces of the Solar System cannot reduce to a mere resultant couple force.

MARTIN GARDINER, C.E.

Brisbane, Queensland, December 14th, 1883.

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